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CoGIP: A Course on 2D Computer Graphics and Image Processing

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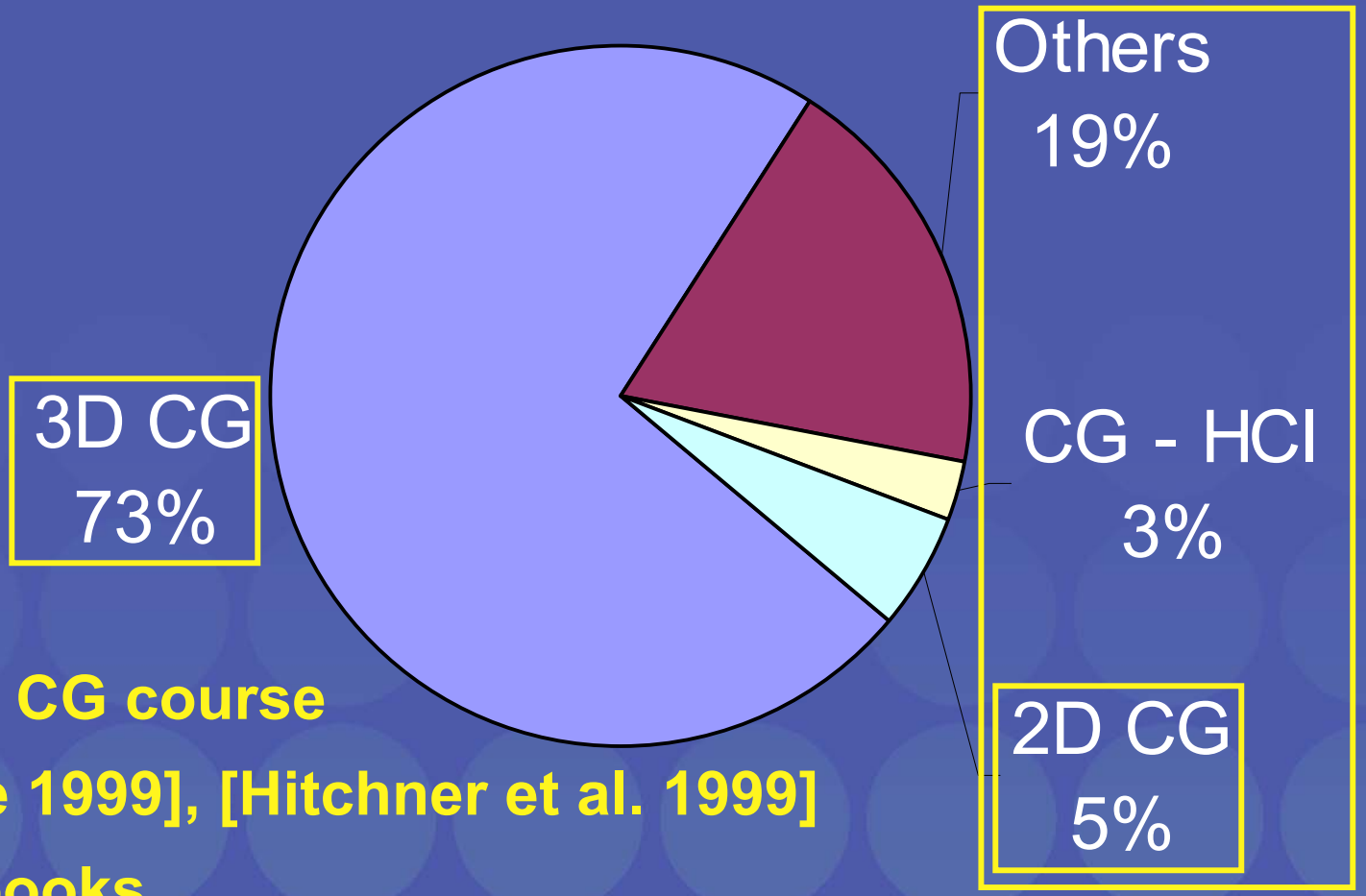
Computer Graphics

- Computer Graphics (CG)
  - 90 % Computer Science curricula
    - 10 % mandatory
  - a vast discipline
    - only a subset in one course

Target for CoGIP

- Undergraduate level
- Computer Science - like programs
- 1st CG course
  - many ways to introduce CG
    - [Brown et al. 1988], [Cunningham 2002], [Grissom et al. 1995], [Larrondo-Petrie et al. 1994]

1st CG Course



Typical 3D CG course

- **[Wolfe 1999], [Hitchner et al. 1999]**
- **Text books**

HCI: Human Computer Interaction

CoGIP

CoGIP Course

- 2D CG and Image Processing course
  - color
  - sampling
  - vector / raster graphics
  - filtering
  - 2D transformations

Overview

- **Motivation**
- Topics
- Labs
- Discussion
- Conclusion

Why?

- Applications
  - web, user interface, visualization, reports, presentations, promotional material, CG content creation, games, special effects, …
- Typical Computer Scientists
  - manipulate images and 2D more often than 3D

Why?

- Quality presentation
  - 2D graphics / images
  - Capture
    - digital camera, scanner, camcorder, …
  - Reproduction
    - ink jet, laser, film, monitor, lithography, Web, …

Overview

- Motivation
- **Topics**
  - **covered topics**
  - **relationships**
  - **book**
- Labs
- Discussion
- Conclusion

CoGIP Topics

- Color
  - perception, models, transformation
- Sampling
  - aliasing / antialiasing
- Acquisition / reproduction
- Vector primitives
  - lines, polylines, parametric curves, etc.
  - rasterization
- Filling
- Filtering
- 2D transformations

CoGIP Topics

- **Color**
  - **perception**, **models**, transformation
- Sampling
  - aliasing / antialiasing
- Acquisition / reproduction
- Vector primitives
  - lines, polylines, parametric curves, etc.
  - rasterization
- Filling
- Filtering
- 2D transformations

CoGIP Topics

- Color
  - perception, models, transformation
- **Sampling**
  - **aliasing** / antialiasing
- **Acquisition** / reproduction
- Vector primitives
  - lines, polylines, parametric curves, etc.
  - rasterization
- Filling
- Filtering
- 2D transformations

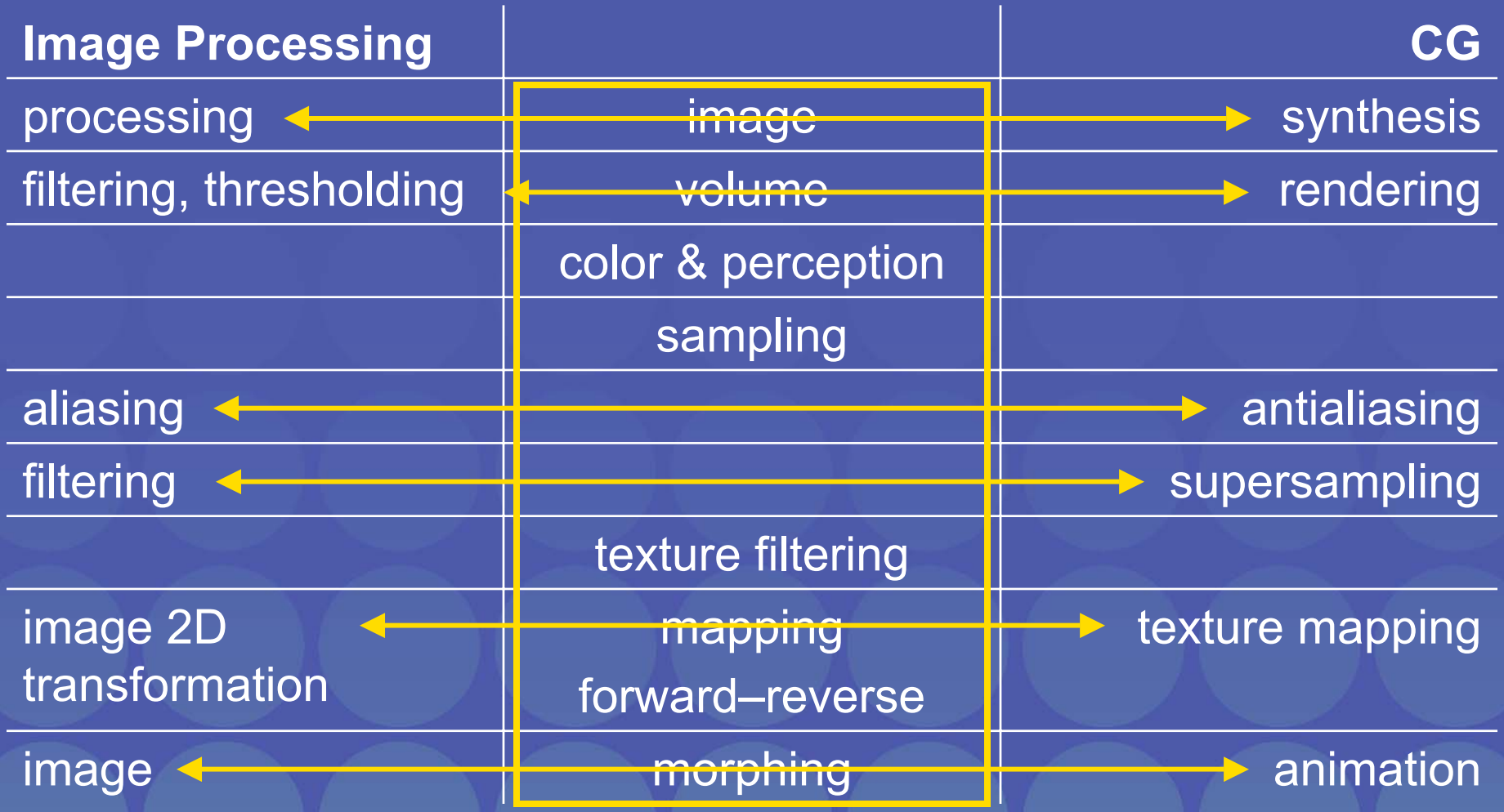
CoGIP Topics

- Color
  - perception, models, **transformation**
- **Sampling**
  - **aliasing** / **antialiasing**
- Acquisition / reproduction
- **Vector primitives**
  - **lines, polylines, parametric curves, etc.**
  - rasterization
- **Filling**
- **Filtering**
- **2D transformations**

CoGIP Topics

- Color
  - perception, models, **transformation**
- **Sampling**
  - **aliasing** / **antialiasing**
- Acquisition / **reproduction**
- Vector primitives
  - lines, polylines, parametric curves, etc.
  - **rasterization**
- Filling
- Filtering
- 2D transformations

Shared Topics



Shared Advanced Topics

Image Processing		**CG**
shape from shading		shading
stereo	projection	image synthesis
brightness, contrast, gamma		**HDRI mapping**
image compression	wavelets	**multiresolution surfaces**
analysis	texture	**synthesis**
	3D reconstruction	

HDRI: High Dynamic Range Imagery

CoGIP Book

- No appropriate book
  - topics not covered in appropriate depth
  - missing topics

Our Books and Chapters

[Watt & Policarpo 1998], ch. 25	perception, color
[Hill 2001], ch. 10	sampling, vector primitives, reproduction, filling
[Effort 2000], ch. 7	image filtering (spatial)
[Gonzalez & Woods 2002], ch. 5	image filtering (frequency)
[Foley et al. 1990], ch. 11	curves
[Hearn & Baker 2004], ch. 5	transformations

Overview

- Motivation
- Topics
- **Labs**
  - **lab topics**
  - **J2DCG lab tool**
- Discussion
- Conclusion

CoGIP Labs

Topic	CG / IP (Image Processing)	Vector / Raster
Color models	both	both
Filling	CG	raster
Filtering	IP	raster
Curves	CG	vector
Transformations	CG (and some IP)	vector (and some raster)

J2DCG

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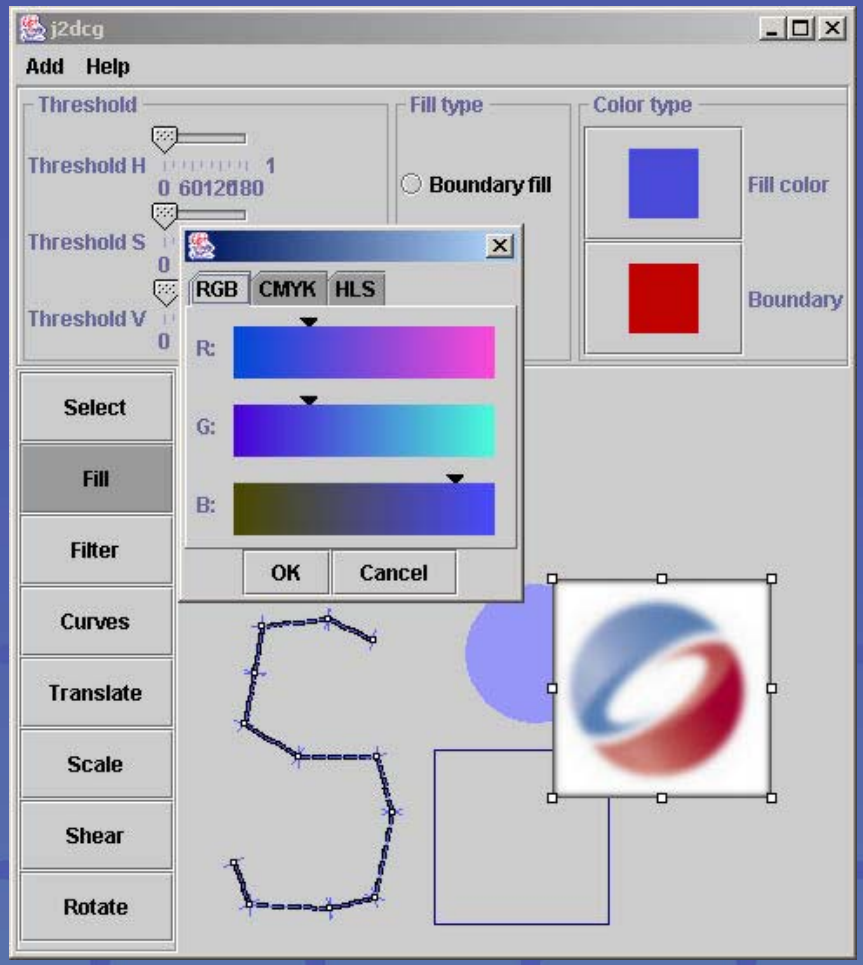
- Focus
  - integrated vector & raster graphics
  - less coding effort
- OpenSource project
  - j2dcg.sourceforge.net/



Overview

- Motivation
- Topics
- Labs
- **Discussion**
  - **benefits**
  - **challenges**
- Conclusion

Advantages

- Advantage compared to 3D CG course
  - perception
  - color
  - acquisition / reproduction
  - image transformation
  - image composition
  - vector graphics

Benefits for students

- Efficient with 2D graphics software
  - create, edit, reproduce quality content
- Knowledge to interact with
  - CG & Image Processing specialists

Benefits for teachers

- Require similar knowledge
  - mathematics
  - programming
- Less duplication with Image Processing
- Starting point for advanced courses
  - Vision, 3D CG, animation, …

Challenges

- Division
  - CG / Image Processing
  - Vector / Raster
- No appropriate book
- Advanced course
  - must follow CoGIP before
  - must refresh their memory

GTI410: Our Experience

- Students appreciate
  - topics
  - labs
  - labs in a single system
- Course notes from chapters
  - appropriate
- Advanced course on 3D

Overview

- Motivation
- Topics
- Labs
- Discussion
- **Conclusion**

Conclusion

- Good combination
  - natural integration
  - less duplication
- Good starting point for advanced courses
- Good for many curricula

Future Work

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- Approaches
  - (interactive) 3D CG
  - 2D CG and Image Processing
  - interactive 3D CG and HCI
  - others
- Which approach, when, where?

Acknowledgments

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  - NSERC
  - ETS

Additional Material

References

- Books
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Contributions

- Description of a course on 2D CG & IP
- Identification of practical / theoretical relationships between 2D CG & IP
- Relationship to advanced courses
- Identification of benefits and drawbacks
- OpenSource Framework for labs
- Survey on CG courses

2D to 3D CG

2D CG + Image Processing		Advanced CG
2D	curves	3D, surfaces
2D	transformations	3D, projection
2D	animation	3D, gimbal lock
2D vector	primitives	polygon, sphere, torus, etc.
DDA, mid point	vector to raster	scanline

DDA: Digital Differential Analyser

CoGIP Lab Tool

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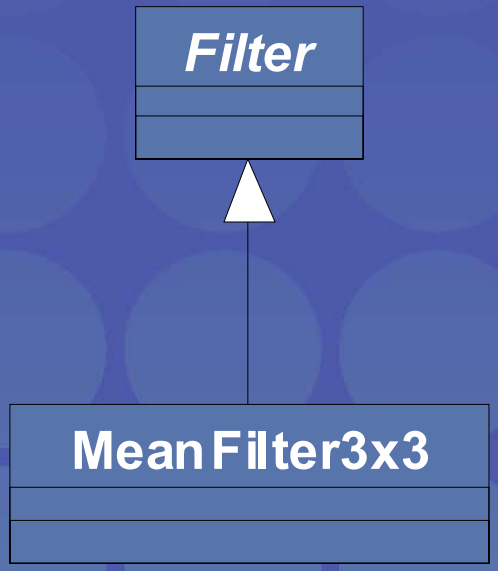
- Focus
  - easily implement the algorithms
    - less coding effort
    - less user interface development

Abstract class



Example concrete class

Books constraints

- [Watt & Policarpo 1998]
  - insufficient details
- 3D CG books
  - insufficient filtering, image transformations
- IP books
  - insufficient vector primitives, curves, vector to raster, filling, 2D transformations, reproduction

Data

- From data available on the Web
- Undergraduate CS curricula
- Number of
  - 5 countries
  - 31 universities
  - 50 programs
  - 37 introductory CG courses

Data

- Countries
  - Australia
  - Canada
  - New Zealand
  - United Kingdom
  - United States

IT Engineering

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- Information Technology Engineering
- Applied Computer Science
  - business
  - transactional environment
  - information technology
  - internet / intranet
- Integrators

IT Engineering (GTI)

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- Curriculum

Engineering	CHM101 ING120 MAT115	COM110 MAT235 PHY102	ING130 MAT320 PHY105	GIA450 MAT415	GIA400 MAT140	GPO661 TIN501 GIA601[1]	GTI790
Computer Science	LOG120	LOG220	LOG340 GTI310[2]	GTI440[2]			
Computer Graphics				**GTI410**		GTI664	GTI420[1]
Network				LOG610	GTI525 GTI530		GTI710
Business		GTI210			GTI520		